

Application No. 10/065,448
Docket No. DP-307129
Amendment dated April 19, 2004
Reply to Office Action of January 20, 2004

REMARKS

In the Office Action, the Examiner reviewed claims 1-20 of the above-identified US Patent Application, with the result that claims 1-6, 8-15, and 17-20 were rejected under 35 USC §103 as being unpatentable in view of U.S. Patent No. 5,100,479 to Wise et al. (Wise) and U.S. Patent No. 6,294,787 to Schieferdecker et al. (Schieferdecker), and claims 7 and 16 (which depend from claims 1 and 13, respectively) were deemed to recite allowable subject matter. In response, Applicants have amended the specification and claims as set forth above. More particularly:

The specification has been amended to identify Attorney Docket No. DP-306616 by its serial number.

Dependent claim 4 has been amended to recite that the metal body (42) is between the at least two dielectric layers (36,46) in tension. Support for this amendment can be found in Applicants' specification at paragraph [0023] and Figure 1.

Dependent claim 5 has been amended to clarify the metal body as being a metal rim (48) that overlaps a boundary between the diaphragm (30) and frame (18) so as to be aligned with an edge defined by the cavity (32) in the substrate (20). Support for this amendment can be found in Applicants' specification at paragraph [0024] and Figure 1.

Applicants believe that the above amendments do not present new matter. Favorable reconsideration and allowance of claims 1-20 are respectfully requested in

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view of the above amendments and the following remarks.

Rejection under 35 USC §103

As noted above, independent claims 1 and 13 and dependent claims 2-6, 8-12, 14, 15, and 17-20 were rejected under 35 USC §103(a) as being unpatentable over Wise in view of Schieferdecker. Applicants note that Wise is merely the divisional of U.S. Patent No. 5,059,543, which Applicants cited in their IDS filed October 18, 2002.

Applicants respectfully traverse this rejection in view of the following comments.

Applicants' invention is directed to a process using integrated sensor technology in which a micromachined sensing element (12) and circuitry (14) are combined on a single semiconductor substrate (20) to form, for example, an infrared sensor (10). The process produces an improved layered micromachined member, such as a diaphragm (16), after the circuit fabrication process is completed. The process generally entails forming a circuit device (14) on the substrate (20) by processing steps that include forming multiple dielectric layers (34,36,46,etc.) and at least one conductive layer (22,40,50,54) on the substrate (20). The dielectric layers (34,36,46) comprise an oxide layer (34) on a surface of the substrate (20) and at least two dielectric layers (36,46) that are in tension, with the conductive layer (22,40,50,54) being located between the two dielectric layers (36,46). The surface of the substrate (20) is then dry

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etched to form a cavity (32) and delineate the diaphragm (16) and a frame (18) surrounding the diaphragm (16). The dry etching step terminates at the oxide layer (34), such that the diaphragm (16) comprises the dielectric layers (34,36,46) and conductive layer (22,40,50,54). A special absorber (42) is preferably located between the dielectric layers (36,46) in tension to promote efficient absorption of incoming infrared radiation.

Under the §103 rejection, the Examiner stated that Wise discloses Applicants' process for forming a thermopile sensor except for dry etching a cavity of the sensor, but then cited Schieferdecker for disclosing dry etching (DRIE) a cavity for a thermopile sensor. Regarding Wise, the Examiner explained that Wise discloses

multiple dielectric layers (40) and at least one conductive layer (34) on the substrate (50), the multiple dielectric layers comprising an oxide layer (40) on a surface of the substrate (50) and at least two dielectric layers that are in tension, the at least one conductive layer (34) being between the at least two dielectric layers . . .

However, Wise does not disclose "at least two dielectric layers that are in tension, the at least one conductive layer (34) being between the at least two dielectric layers." Wise discloses a dielectric diaphragm 40 that contains a silicon nitride layer sandwiched between two silicon dioxide layers. See column 6, lines 42-59. Wise's conductive layer 34 is not between the dielectric layers that are in tension within the diaphragm 40, but instead lies on top of the diaphragm 40 - i.e., outside the dielectric layers in tension.

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While Wise discloses that

By adjusting the relative thickness of these [oxide-nitride-oxide] layers, the overall stress of the composite dielectric [diaphragm 40] may be adjusted to be in mild tension which is desirable to avoid mechanical flexing of the membrane in response to ambient temperature changes

Wise does not disclose or suggest a diaphragm such as Applicants' in which conductive layers (e.g., polysilicon legs of the thermopiles 22, metal layer 40) actually lie between dielectric tensile films (36,46) so as to be within the dielectric diaphragm structure, the benefits of which Applicants explain as follows:

the process of this invention forms tensile films both above and below the conductive layer to provide good adhesion while converting to tensile the net stress in the composite dielectric stack, such that the potential is reduced for yield losses attributable to compressive stresses within the dielectric stack.

Paragraph [0007].

Applicants believe that Schieferdecker does not supplement the teachings of Wise in order to arrive at Applicants' invention, since Schieferdecker merely discloses the use of dry etching to form a cavity of a thermopile sensor, but does not disclose anything further regarding the placement of dielectric tensile films within a dielectric diaphragm, e.g., Schieferdecker's insulating layer 51.

In view of the above, Applicants' believe that the combination of Wise and

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Schieferdecker does not obviate Applicants' claimed invention under 35 USC §103.

The following comments are in response to arguments made by the Examiner that were directed to certain of the rejected claims.

Specifically regarding claims 4 and 5, the Examiner made the statement:

... further comprising the step of forming a metal body (36) so as to be within the diaphragm for reflecting thermal energy through at least one of the multiple dielectric layers toward the hot (cold) junctions of the thermopiles.

However, the "metal body (36)" cited by the Examiner is merely the metal thermocouples 36 of Wise's thermopile 24, which are not located "within the diaphragm for reflecting thermal energy." In any event, Applicants' claim 4 now requires the metal body (42) to be between the at least two dielectric layers (36,46) in tension, which is contrary to Wise for the same reasons as discussed above.

With respect to claim 5, the Examiner did not explain how Wise's metal thermocouples 36 could be described as "surrounding the hot junctions of the thermopiles, and between the hot and cold junctions of the thermopiles . . . to equalize thermal energy at the cold junctions." In any event, the metal body of claim 5 is now clarified as being the metal rim 48 that overlaps the boundary between the diaphragm 16 and frame 18 so as to be aligned with an edge defined by the cavity 32 in the substrate 20. Wise lacks any teaching regarding a "rim" having the shape, location and

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function required of Applicants' rim 48.

Specifically regarding claims 8 and 9, the Examiner stated that Wise discloses the use of an oxynitride layer as one of the at least two dielectric layers in tension. To the contrary, Wise discloses a silicon nitride layer sandwiched between two silicon dioxide layers. Applicants performed a word search of Wise's text and could not find any reference to "oxynitride." This same argument applies to claims 17 and 18.

Aside from the explanation for rejecting its parent claim 1, the Examiner did not state a reason for rejecting claim 10. However, neither Wise nor Schieferdecker discloses or suggests a dry etching step that simultaneously defines an infrared-absorbing body within a cavity (e.g., Wise's cavity 22 or Schieferdecker's "depressions" 33 in Figure 3A) and on a micromachined member (e.g., Wise's diaphragm 40 or Schieferdecker's insulating layer 51).

Specifically regarding claims 11 and 12 (which depend from claim 10), the Examiner stated that Schieferdecker discloses the use of "an additional anisotropic or isotropic etch to complete the cavity. See column 5, lie 20 to 45." However, Schieferdecker does not disclose such additional etch steps as resulting in "a portion of the substrate remaining in the cavity to define the infrared-absorbing body surrounded by the trench" (claim 11), or "defining a first opening in the mask and a plurality of second openings in the mask that are smaller than the first opening, the first opening being continuous and surrounding the plurality of second openings; and then dry etching

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the substrate through the first and second openings in the mask using first etch conditions to define a trench that stops at the oxide layer and then using second etch conditions different from the first etch conditions to form the infrared-absorbing body surrounded by the trench" (claim 12; emphasis added). The arguments regarding claims 11 and 12 also apply to claims 19 and 20.

Finally, specifically regarding independent claim 13, the Examiner stated that Wise discloses "forming a second tensioned dielectric layer (38) so that the first conductive layer [36] is between the first and second tensioned dielectric layers." (Applicants presume the first tensioned dielectric layer is the oxide-nitride-oxide stack of Wise's diaphragm 40.) However, Applicants cannot find any statement in Wise that the dielectric (insulator) layer 38 is in tension.

For all of the above reasons, Applicants respectfully request withdrawal of the rejection to the claims under 35 USC §103(a).

Closing

In view of the above, Applicants believe that the rejection of their claims has been overcome, and that the claims define patentable novelty over all the references, alone or in combination, of record. It is therefore respectfully requested that this patent application be given favorable reconsideration.

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Should the Examiner have any questions with respect to any matter now of record, Applicants' representative may be reached at (219) 462-4999.

Respectfully submitted,

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